

Power: 3ϕ

Input real Power: $P_m = 3 R_e \{3 \bar{V}_s \bar{I}_s^*\}$

Stator Copper loss: $P_{sCL} = 3 |\bar{I}_s|^2 R_s$

Rotor Copper loss: $P_{rCL} = 3 |\bar{I}_r|^2 R_r'$

Mechanical Power: $P_m = 3 |\bar{I}_r'|^2 R_r' \left(\frac{1-s}{s}\right)$

$$T^e = \frac{P_m}{\omega_m}$$

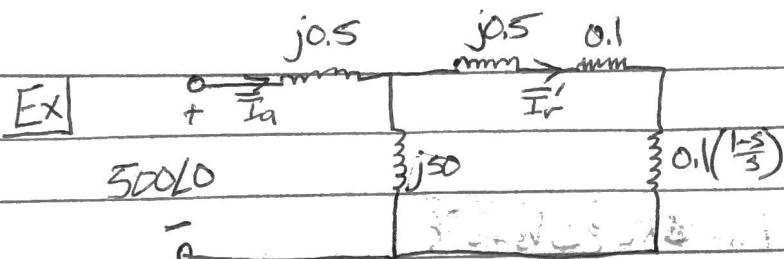
Shaft Power: $P_{shaft} = P_m - \underbrace{P_{rot}}_{\text{Rotational power-loss}}$

Power Across Air Gap: $P_{AG} = 3 \frac{|\bar{I}_r'|^2 R_r'}{s} = \frac{P_m}{1-s}$

$$P_m = (1-s) P_{AG}$$

Multi-pole Systems: $\omega_m = (1-s) \omega_s \left(\frac{2}{p}\right)$

$$T^e = \frac{(1-s) P_{AG}}{(1-s) \omega_s \left(\frac{2}{p}\right)} \Rightarrow \boxed{T^e = \frac{P_{AG}}{\left(\frac{2}{p}\right) \omega_s}}$$



$$s = 0.05 \quad f = 60 \text{ Hz}$$

2 pole

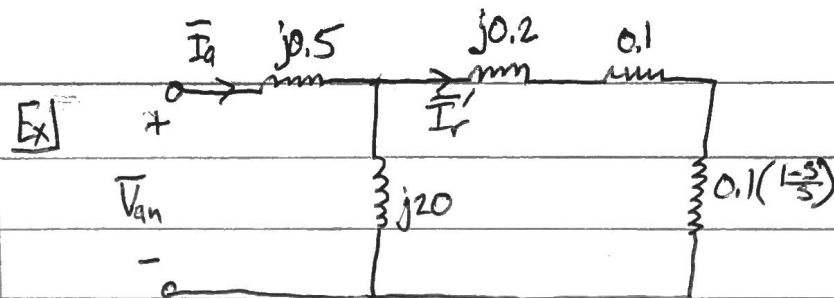
from last time: $\bar{I}_a = 224.014 \angle -28.71^\circ \text{ A}$
 $\bar{I}_r = 221.606 \angle -26.452^\circ \text{ A}$

find: T_e

$$P_{AG} = 3 |\bar{I}_r|^2 \left(\frac{R_f}{s} \right) \Rightarrow P_{AG} = 3 (221.606)^2 (2) = 294.655 \text{ kW}$$

$$P_m = (1-s) P_{AG} \Rightarrow P_m = 279.923 \text{ kW}$$

$$T_e = \frac{P_m}{\omega_s} \Rightarrow T_e = 781.597 \text{ Nm}$$



3 ϕ , wye connected

$$f = 60 \text{ Hz}$$

$$V_L = 400 \text{ V}$$

$$p = 4$$

$$N_r = 1755 \text{ rpm}$$

Find: T_e

Solution: $N_s = \left(\frac{2}{p}\right) 2\pi(60) \left(\frac{60}{2\pi}\right) \Rightarrow N_s = 1800 \text{ rpm}$

$$s = \frac{N_s - N_r}{N_s} \Rightarrow s = \frac{1800 - 1755}{1800} \Rightarrow \boxed{s = 0.025}$$

$$\bar{I}_a = \frac{\bar{V}_{an}}{Z_{eq}} \Rightarrow \bar{I}_a = \frac{230.94/0}{4.041/20.958^\circ}$$

$$\boxed{\bar{I}_a = 57.149/-20.958^\circ}$$

$$\bar{I}_r' = \frac{230.94/0 - j0.5\bar{I}_a}{4 + j0.2} \Rightarrow \bar{I}_r' = 222.237/-6.893^\circ \Rightarrow \bar{I}_r' = 55.512/-9.756^\circ$$

$$P_{AG} = 3(55.512)^2(4) \Rightarrow P_{AG} = 36.978 \text{ kW}$$

$$T_e = \frac{P_{AG}}{\frac{2}{p}\omega_s} \Rightarrow T_e = \frac{36.978 \text{ kW}}{\left(\frac{2}{4}\right)(2\pi(60))} \Rightarrow \boxed{T_e = 196.18 \text{ Nm}}$$